09/806676

0 3 APR 2001

IN THE MATTER OF an application
for a GERMAN Patent

in the name of

under application no.

VERIFICATION OF TRANSLATION

I, Walter H. Herzberg

of 5-21 Elizabeth St. Fair Lawn, NJ 07410, USA, do solemnly and sincerely declare that I am proficient in the English and the German languages and am a competent translator thereof, and that the attached document in the English language, the title of which is IMBALANCE COMPENSATION DEVICE FOR CENTRIFUGES is, to the best of my knowledge and belief, a true and faithful translation of the certified copy of the German Patent Application no.

Dated this fifteenth day of March, 2001

Walter Herzberg

(signature and name of translator)

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DT-3905

IMBALANCE COMPENSATION DEVICE FOR CENTRIFUGES

Field of Invention

The invention relates to a device of the type, defined in the introductory portion of claim 1.

Background Information and Prior Art

In the case of an imbalance of the rotor, which is produced, for example by asymmetric loading, such a device compensates for imbalance owing to the fact that the weight-affected compensating ring is shifted during the rotation of the rotor as the bearing device yields in a direction opposite to the imbalance weight and compensates for the imbalance by these means.

A generic device of the type mentioned above is known from the DE 4293504 A1, the bearing device of which has several radially acting springs, which are disposed spaced apart at the periphery. However, this construction has appreciable disadvantages.

To begin with, the radially acting force of the springs of the bearing device is different for different peripheral angles, depending on the distance separating the peripheral angle from the adjacent springs. This results in nonuniform relationships, which interfere with the compensation for the imbalance. Furthermore, the individually constructed springs can be matched to the same spring force only with difficulty; this also

results in interferences with the compensation of the imbalance. Moreover, the undampened springs of the bearing device, which are provided in the case of the known construction, form a system capable of vibrating, which is a source of additional, undesired resonances. In addition, the known bearing device is effective essentially only in the plane of the bearing device and not against tilting deflections. Finally, it is also very expensive to produce the known construction.

For these reasons, the known device is suitable only for slight imbalance requirements at a low rpm, as in the case of a washing machine, demonstrated in the publication cited. It is not very suitable for high-speed centrifuges.

Object of the Invention

It is an object of the present invention to develop the generic device to save costs and meet higher imbalance requirements.

Summary of the Invention

This objective is accomplished with the distinguishing features of claim 1.

As bearing device, the inventive device has an elastic ring. In the simplest case, the compensating ring is, for example, a steel ring of suitable weight fastened to the surface of the rotor over an elastic ring in the form of a rubber layer. Obviously, such a construction is very cost-effective. The annular shape of the elastic ring, which can be constructed symmetrically all around and makes possible the same (isotropic) elastic

properties under all peripheral angles, is an advantage. Such an elastic ring can be constructed so that it will dampen well. Resonance frequencies then do not occur, so that additional resonances are not formed in the vibratory system of the centrifuge. Depending on the cross sectional geometry, the elastic ring can produce very good restoring forces also in the tilting direction of the rotor axis with respect to the compensating ring and, with that, also compensate for tilting movements very well. With this, an imbalance compensation in several degrees of freedom is produced in a simple manner. At low cost and because of its simple construction, the inventive device is therefore suitable for centrifuges of all types, especially also for high-speed centrifuges, such as especially laboratory centrifuges, which can also be retrofitted.

The device can be mounted at different concentric surfaces of the rotor, for example, at the rotor container provided for accommodating the material to be centrifuged. Advantageously, however, in accordance with claim 2, it is intended to be mounted at the drive shaft, for example, in the vicinity of the rotor container. By these means, the mounting is simplified.

The device may be provided at a concentric outer surface of the rotor, for example, at the periphery of the rotor container or particularly advantageously by mounting it on the outside of the shaft. Advantageously, however, in accordance with claim 3, it is disposed at a concentric inner surface, particularly at an inner surface of the rotor container. This leads to a particularly space-saving construction.

Advantageously, the elastic ring of claim 4 is constructed as an elastomeric ring. Suitable elastomers, such as natural rubber or a synthetic elastomer can be used. Especially the spring action, which is uniform in all directions, and the good inherent damping of the material are of advantage here.

The elastomeric ring can be constructed in one piece. Advantageously, however, in accordance with claim 5, it is constructed in several layers. These layers can be separated by planes disposed perpendicularly to the axis or especially also as concentric layers disposed in the radial direction above one another. The rebounding and damping properties of the elastomeric ring can be optimized by the multilayer construction with layers having different elastomeric parameters.

Advantageously, in accordance with claim 6, a seating ring is provided on the side of the elastomeric ring, intended to be fastened to the rotor. This seating ring consists, for example, of metal and makes possible a regular metal-to-metal fastening of the device.

The compensating ring, which preferably consists of metal, the elastic ring and an optionally provided seating ring can be inserted loosely one inside the other and held together by additional devices. Advantageously, however, in accordance with claim 7, they are permanently connected with one another into a structural unit, thus improving the installability and the functional reliability.

Preferably, the elastomeric ring of claim 8 consists wholly or partially, for example in one or several layers, of an elastomeric foam which, because of its special elasticity property, enables the rebound and damping properties of the elastomeric ring to be optimized further.

Advantageously, according to claim 9, the elastic ring is constructed as an obliquely wound helical spring. With this construction, radial elastic properties can be achieved, which are similar to those of an elastomeric ring, however, with the advantages, for example, of a better heat stability and chemical resistance. Good inherent damping can also be attained here due to frictional damping resulting from the multiple contacts of the threads of the screw.

The invention is shown by way of the example and diagrammatically in the drawings, in which

Figure 1 shows a section through a laboratory centrifuge with several imbalance compensating devices with an elastomeric ring,

Figure 2 shows one of the imbalance compensating devices shown in Figure 1 in an axial view in section along the line 2-2,

Figure 3 in a representation similar to that of Figure 2 shows a variation of the imbalance compensating device,

Figure 4 in a representation similar to that of Figure 2 shows a further variation of the imbalance compensating device,

Figure 5 shows a further variation of the imbalance compensating device in a sectional view of Figure 1 and

Figures 6 and 7, in different sectional representations, show an imbalance compensating device, which is disposed on the shaft of the centrifuge and has a helical spring as elastic ring.

In Figure 1, a laboratory centrifuge of the usual construction is shown, the outer protection of housing has been omitted.

A drive motor 3, which is mounted elastically with springs 2, is disposed on a base plate 1. It drives a perpendicular shaft 4 for a rotor, which consists of the shaft 4 and a rotor container 5.

The rotor container 5 has several receptacles 6, for accommodating sample tubes 7, which are to be centrifuged. In order to explain imbalance, there is a sample tube 7 in only one of the two opposite receptacles 6, the opposite receptacle 6 being empty. As a result, an appreciable imbalance is produced, for which compensation is required.

To compensate for the imbalance, an imbalance compensating device I is provided at the shaft 4. The device I consists of a compensating ring 8 and of an elastic ring in the form of elastomeric ring 9. This device I is shown once again on an enlarged scale in Figure 2 in an axial view along the sectional line 2-2 in Figure 1. It can be seen that the elastomeric ring 9, which may consist of any suitable natural or synthetic elastomer, permits the compensating ring 8, which is encumbered with a suitable mass and consists, for example, of steel, to be shifted radially relative to the shaft 4. The telling movements of the shaft 4 with respect to the plane of the compensating ring 8 are also compensated for in the elastomeric ring 9. The elastomeric ring 9 can have the usual elastomeric properties and thus, in particular, not only acts elastically, but also has significant damping properties.

Figure 1 shows that an imbalance compensating device, with an elastomeric ring 9 and a compensating ring 8, can be constructed so that it can be mounted at different positions on the rotor.

A compensating device II may be provided on the periphery of the rotor container 5. A compensating device III may be provided at the lower front surface of the rotor container 5, with the special feature that the elastomeric ring is stressed in shear here. In the case of the construction of the rotor container 5, shown, with a lower recess with a cylindrical inner surface 10, a compensating device IV is particularly advantageously disposed on this cylindrical surface 10, the compensating ring 8 ring then

being on the inside and the elastomeric ring 9 on the outside of the inner surface 10 of the rotor container 5. A compensating device V, can also, as shown in Figure 1, be disposed at the shaft 4 protruding downward beyond the motor 3.

A compensating device VI can furthermore also be disposed within the rotor container 5 at a cylindrical inner surface 10'. In the case shown, as indicated by Figure 1, the compensating ring 8' can also be constructed as a solid disk.

The most suitable site I to IV for mounting the compensating device can be selected depending on the oscillating behavior of the centrifuge as shown in Figure 1. Advantageously, several compensating devices may also be disposed, for example, in positions I and IV in order to compensate for imbalance better.

Variations of the compensating device, disposed in position I of Figure 1 and explained in the following, are possible. Modified appropriately, they can also be used for the compensating devices shown in the other positions.

In Figure 3, a construction is shown which, with the compensating ring 8 and the elastomeric ring 9, aside from other dimensions, corresponds to the construction of Figure 2. Within the elastomeric ring 9, however, a seating ring 11, consisting, for example, of steel is additionally provided and is constructed to fit snugly on the shaft 4.

The embodiment of Figure 4 corresponds to that of Figure 3 with the exception of the fact that the elastomeric ring consists of two concentric layers 9', 9", which consists of different elastomeric materials and have, for example, different elastic or damping properties. The compensating behavior of the elastomeric ring 9', 9" can be optimized by these means.

Figure 5 shows a variation of the construction shown in Figure 3, for which the compensating ring 8, enclosed all around, is disposed in the elastomeric ring 9. By these means, the compensating properties, as well as the ease of fabrication and the fatigue strength can be improved.

For all the embodiments of the compensating device shown, the parts 8, 9, 11 in particular may be connected permanently with one another, for example, by gluing or vulcanizing, in order to create a construction, which is secured against shifting and can be handled easily during the installation.

In the embodiment shown, the elastomeric ring 9 may consist of a pore-free elastomeric material, especially however also of an elastomeric foam, the special elastic and damping properties of which can be utilized advantageously here. In the case of embodiment 4, for example, one of the layers 9', 9" may consist of elastomeric foam or also both layers may consist of different foams.

In the embodiment shown, the elastomeric ring 9 is represented with a rectangular cross-sectional shape. Moreover, its radial thickness and its thickness extending in the axial direction of the shaft 4 can be adapted the desired balance parameters, particularly also with regard to the ratio of the radial elasticity to the tilting elasticity.

The cross-sectional geometry can advantageously also be different, for example, with a spherical curvature of the front surface of the elastomeric ring or with hollow surfaces, as shown by the elastomeric ring 9' of the balancing device VI, in order to adjust its elasticity properties in a desired manner. For the same purpose, the elastomeric ring can also, for example, be provided with cavities or openings distributed over the periphery, provided that the elastic properties, which are kept as far as possible the same under all angles (isotropic), are not affected excessively by this arrangement of cavities and openings.

In different sectional representations, Figure 6 and 7 show a further embodiment of an imbalance compensating device, which may be mounted, for example, on the shaft 4 in position I of Figure 1. If appropriately modified constructively, it may also be suitable for the other mounting positions II to IV of Figure 1.

For the embodiment of 6 and 7, the elastic ring is constructed not as an elastomeric ring, but as an annular helical spring 19. The latter is supported, on the one hand, in a peripheral outer grove 16 of the seating ring 11 and, on the other, in a

peripheral inner grove 17 of the compensating ring 8, so that the imbalance compensating device forms a positively connected installation unit. As shown by Figure 6, the cross-sectional shapes of the grove 16 and 17 are adapted to the cross-sectional peripheral shape of the helical spring 19.

In the case of a normally wound helical spring, the individual convolutions are essentially radial in the view shown by Figure 4. However, as shown in Figure 7 for the diagrammatically demonstrated helical springs 19, which can be used for the present purpose, the individual convolutions are inclined at an angle α to the radial direction, shown by the line of dots and dashes. By these means, the helical spring 19 can yield elastically in the radial direction in much the same way as the elastomeric ring 9, used in the embodiments of Figures 1 to 5. Tilting motions of the shaft 4 relative to the compensating ring 8 can also be compensated for elastically by the helical spring 19.

The helical spring 19 may consist of suitable spring materials, such as spring steel. Contrary to the elastomeric ring 9, used in the embodiments of Figures 1 to 5, the spring ring 19 and accordingly the whole of the imbalance compensating device, 11, 19, 8 may be constructed, for example, to withstand high temperatures and the action of solvents.

Compared to the elastomer used in the other embodiments, the helical spring 19, used in embodiments of Figure 6 and 7 as spring ring, has the disadvantage of a deficient inherent damping. However, in the case of the embodiment shown in Figures

6 and 7, the helical spring 19 is supported in the grooves 16 and 17 with all its convolutions in point or line contact. In the event of radial compensating movements of the helical spring 19, these contact positions are shifted in sliding motion, which is associated with a corresponding friction. By these means, an adequate damping effect is achieved by frictional damping also for this construction of the elastic ring.

Imbalance Compensating Device for Centrifuges

A device for automatically compensating for the imbalance of the rotor (4, 5) of a centrifuge with a compensating ring (8), which can be supported concentrically in the resting position over an elastic bearing device at a concentric surface of the rotor, wherein the bearing device is constructed as an elastic ring (9,19), which yields at least radially.